

# Plumbing Europa: A magnetotelluric sounder to characterize water layers and habitability within the ice shell of an ocean world

Completed Technology Project (2015 - 2018)



## Project Introduction

Detection of (recently) extant life by a lander on the surface of Europa would rank among the greatest scientific discoveries of all time. Determining the provenance of such lifeforms is critical to understanding the extent of Europa's habitability and to formulating efficient follow-up. The 2012 Europa Lander Study specifies a magnetometer and seismometer to measure the depth and thickness of any water layers present. However, the magnetometer relies on independent information about source fields that is lacking at the shorter periods ( $<100$  s) necessary to resolve water within the ice shell, and the case for seismic discrimination assumes ubiquitous sources and low-loss transmission. Furthermore, orbital or landed surface-penetrating radar is rapidly attenuated when ice contains even minor brine channels. To fill these potential gaps in subsurface knowledge, we propose to develop a magnetotelluric (MT) sounder, which can determine the depth, thickness, and salinity of water layers in the ice shells of ocean worlds. MT is a long-established, broadband approach to determining subsurface profiles of electrical conductivity, and requires only that the previously specified magnetometer is complemented with an electric-field measurement (electrometer). This provides the additional, necessary, constraint for sounding such that independent information about source fields is not required. We propose to develop a prototype MT sounder for Europa (entry TRL 4, exit TRL 6). The system comprises two ballistically deployed electrodes, a boom-mounted magnetometer, and a central electronics box. The remote electrodes must be deployed to 20-m horizontal distance to provide a suitable baseline for electric-field measurement; the magnetometer boom extends 2 m vertically. Sampling rates are higher (256 sps) in order to capture magnetospheric waves. All components have flight heritage – the system is essentially a space-physics suite operated on the ground – so we seek to reduce risk in deployment and operations at the cold and irradiated surface of Europa. Key tasks for TRL 6 are calibration of the magnetometer sensor at low temperature so it can function without heaters, performance and resource requirements for a radiation-shielded and heated remote electrode, radiation shielding requirements for the central electronics, and testing of the electrode launcher. The proposed effort directly addresses the second Europa lander objective called out by CoLDTech, "Assess the habitability of Europa ... via in situ techniques uniquely available to a landed mission." The same techniques can be applied to landers on other ocean worlds, specifically Enceladus and Titan. A successful two-year development and test program will allow the MT sounder to be proposed for the first Europa landing.



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## Organizational Responsibility

### Responsible Mission Directorate:

Science Mission Directorate (SMD)

### Responsible Program:

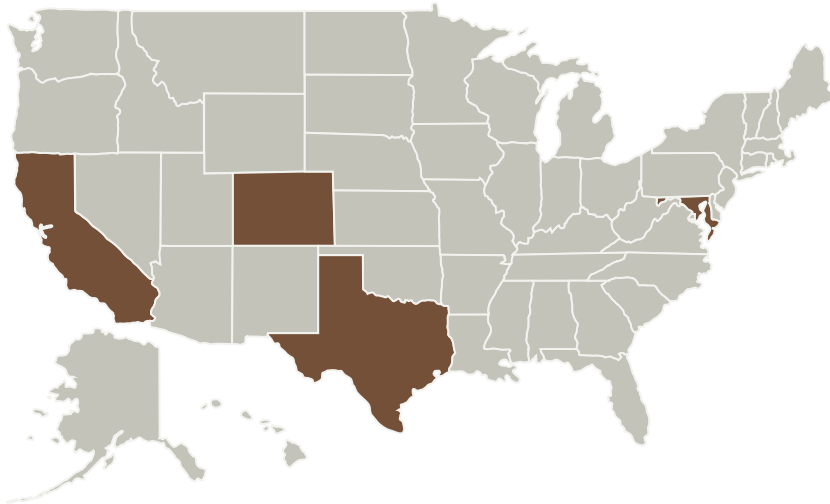
Concepts for Ocean Worlds Life Detection Technology

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## Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
Southwest Research Institute - San Antonio(SWRI)	Supporting Organization	Academia	San Antonio, Texas

Primary U.S. Work Locations	
California	Colorado
Maryland	Texas

## Project Management

### Program Director:

Carolyn R Mercer

### Program Manager:

Carolyn R Mercer

### Principal Investigator:

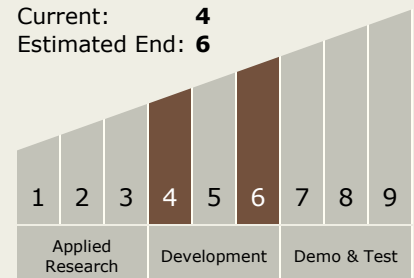
Robert E Grimm

### Co-Investigators:

Jared R Espley  
Dave Sheppard  
Gregory T Delory  
Steven C Persyn  
Ronald B Kalmbach  
Paul S Turin  
David E Stillman

## Technology Maturity (TRL)

Start: 4  
Current: 4  
Estimated End: 6



## Technology Areas

### Primary:

- TX08 Sensors and Instruments
  - TX08.1 Remote Sensing Instruments/Sensors

*Continued on following page.*

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## Technology Areas (cont.)

- └ TX08.1.1 Detectors and Focal Planes

## Target Destination

Others Inside the Solar System